Large Cetacean Analysis for the Santa Barbara Channel Region

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Introduction

The following analysis was undertaken by NOAA's Channel Islands National Marine Sanctuary and Cascadia Research Collective staff to examine the distribution of large cetaceans in and around the shipping lanes of the Santa Barbara Channel where ship strikes are a major concern. This characterization of cetacean sightings will be submitted to the USCG for consideration in their Port Access Route Study (PARS) for the Ports of Los Angeles/Long Beach.

The question of how does ship behavior affect the likelihood of physical proximity to large whales is critically dependent on two pieces of information: 1) what is the likelihood of a whale being in a specific location? and 2) what is the likelihood of a ship being in that same location at the same time? Data is available on ship distributions, as described by Automated Identification System (AIS) data, and has already been provided to the interested parties (NMFS and US Coast Guard). This document is a summary of available data that may inform, but not completely address, the question of cetacean distributions.

About The Data Sets

Two datasets were used to characterize cetacean presence as part of the Port Access Route Study (PARS) analysis in the Santa Barbara Channel region: The Channel Islands Naturalist Corps sightings, and Cascadia Research Collective sightings. The analyses focused on blue, fin, and humpback whales.

Channel Islands Naturalist Corps (CINC) Sightings

The CINC volunteers are a group of specially trained environmental stewards dedicated to educating the public about the Channel Islands National Park (Park) and Channel Islands National Marine Sanctuary (Sanctuary). The CINC volunteers interact with the general public aboard whale watch vessels as well as island concessionaire vessels that transport the general public to the Sanctuary and Park. These vessels operate out of the Santa Barbara, Ventura and Channel Islands Harbors. The CINC volunteers aboard these vessels also act as citizen scientists, recording marine mammal sightings. Information recorded by CINC volunteers

include the date, time, species, geographic coordinates, number of individuals, distance between vessel and animal, behavior and the vessel aboard which the sighting was made.

The resulting sightings data are recorded in the online Marine Mammal Sightings Database (http://www.cisanctuary.org/mammals/). These sightings are collected opportunistically in that effort is determined by the whale watch vessels and the vessels transporting passengers to key island drop-off locations. The sightings span from 1999 – 2010.

The data provide presence-only information on marine mammal distributions. Survey effort of whale watch vessels has not historically been recorded so inferences can only be made where vessels targeted and encountered cetaceans.

Cascadia Research Collective (CRC) Sightings

CRC is a non-profit scientific and education organization that conducts research on threatened marine mammals. It has focused efforts on long-term research of large cetaceans, including blue, fin, and humpback whales, along the West Coast of the United States and off of Central America. CRC researchers conduct photo-identification and tagging to examine population trends, distributions, and behavioral patterns. Data used here are from 1991 to 2009 and reflect more than 500 daily vessel surveys and just over 5,000 sightings conducted primarily by small (<6 m) vessels. Surveys were primarily conducted based out of launch locations including Gaviota, Santa Barbara, Ventura, and Channel Islands Harbors. Also included are some work conducted in conjunction with larger vessels including NOAA ships, Scripps research vessel *Sproul*, and several CINMS vessels including most recently the *Shearwater*. Detailed survey effort and track lines are available but are not incorporated here due to the time constraints and analytical resources needed to complete the analysis on a timeframe that complements the PARS study.

Data Presentation

Study Area

The study area spans the Santa Barbara Channel region including the traffic separation scheme (TSS) and the four northern Channel Islands; San Miguel, Santa Rosa, Santa Cruz, and Anacapa (Figure 1). It extends 18 km to the north, 60 km to the west, and 70 km to the south of Point Conception. The eastern boundary is 35 km east of Anacapa Island, roughly 85 km north of the entrance to the Ports of Los Angeles (LA)/Long Beach (LB). The total study area includes 12,593 km^2.

A variety of human uses occur within the study area. The TSS extends northwest to southeast across the Santa Barbara Channel and acts as one of the main conduits to and from the Ports of LA/LB. In addition, a total of 19 oil and gas platforms exist within the study area.

The seafloor within the study area is complex, including basins, canyons, and pinnacle features. Figure 1 delineates the continental shelf break, defined here as the 200 meter isobath. For purposes of this study, the 200 meter isobath was buffered by 1.6 km on either side and is used to examine associations between cetacean species and the continental shelf break. The 200 meter isobath buffer covers 1,698 km^2, or 13% of the study area.

Mapping Sightings

The CINC and CRC datasets were analyzed separately. In addition, the three species of whales of concern, blue, humpback and fin were also separately analyzed.

Humpback whale seasonal sighting patterns were examined because the sanctuary had prior knowledge that humpback whales have distinct seasonal timing and food choice. Sightings were broken up into two time periods each year: January – May and June – December.

The study area was sectioned into 1km by 1km grid cells. Observations where then placed within a given cell and summed. Once all the observations were placed in a cell and summed, all of the individual cells containing at least one observation were ordered from the least to greatest number of observations within the cell. This distribution was then broken into four equal sized segments or quartiles. The highest quartile includes the 25% of cells that contain the greatest number of observations. Likewise, the lowest quartile is the 25% of cells with at least one observation that have the lowest number of observations. The separation of the middle quartiles is statistically the median of the population of all cells with at least one observation in them.

Sightings Correlated with 200 meter Isobath Buffer

The association between sightings and the 200 meter isobath was examined by clipping the whale observations within the buffered area. The relative proportion of sightings spatially overlapping the isobath buffer was calculated for each dataset and species.

Geographic bias in sighting effort

This preliminary analysis does not attempt to correct for the locations of survey effort, this is something that will be worth conducting in additional analyses.

Both sets of surveys focused higher effort in locations where whales were known to occur based on prior experience and also had geographic constraints based on proximity to bases of operations. Whale watch vessels tend to try to find whales as close as possible to their base of operations (Santa Barbara, Ventura, or Channel Islands Harbors) to reduce transit times and tend

to stop and stay in areas where whales are initially encountered. CRC surveys tended to sample and spend time where whales were being encountered to obtain identification photographs and to capitalize other research opportunities. Because a primary goal of the photo-ID effort was to obtain identifications of as many individuals using the region as possible, surveys would typically search additional areas to find new whales once the whales in an area had been photographed. Routes to and from bases of operation (Gaviota, Santa Barbara, Ventura, and Channel Islands Harbors) were also more likely to be searched than those farther away.

Key possible biases that should be kept in mind include: 1) absence or lower number of sightings in an area may in part reflect lower effort in that area; 2) presence-only data can only tell us 'This is where we see whales when we go looking for them' and record their locations 3) concentration patterns in sightings may be exaggerated by greater survey effort of those specific areas. An important way to evaluate the impact of the possible biases is to compare the results of the two datasets, since they have somewhat different biases, and also to compare the results among species, since differences would be the result of differences in species occurrence since they are based on the same effort.

Results

Blue Whales

A total of 1,699 CINC sightings were reported from 1999 – 2010. Almost all of the CINC sightings occur within the Santa Barbara Channel (Figure 2). The greatest concentration of sightings, as indicated by the greatest percentiles in Figure 2, co-occurs with the 200 m isobath north of Santa Rosa and western Santa Cruz Islands. The eastern extent of the 'hot spot' adjoins the TSS southbound shipping lane.

A total of 4,558 CRC sightings were collected from 1991 – 2009. The CRC sightings show two areas of relatively higher concentrations (Figure 3). One of the areas is north of Santa Rosa and western Santa Cruz Island, coinciding with the CINC 'hot spot'. The second extends northwest-west of San Miguel Island. In addition, a smaller area of sightings occurs at the northern extent of the study area, northwest of Point Conception. The areas of highest concentration appear to show a strong correlation with the 200 m isobath.

Fin Whales

Significantly fewer fin whales were observed by both projects as compared to blue whales. A total of 50 CINC sightings were collected. All sightings consisted of a single individual and sightings are scattered throughout the eastern portion of the Santa Barbara Channel with a few sightings south of Santa Cruz and Anacapa Islands (Figure 4). The CRC sightings include 122 sightings. The greatest number of sightings occurs southwest of San Miguel Island (Figure 5).

Humpback Whale Sightings

The CINC humpback whale sightings during January – May include 1,000 sightings from 1999-2010. The map shows the greatest concentration in the inshore waters off of Santa Barbara, California, in areas that are generally shallower than the 200 m isobath (Figure 6). Less concentrated sightings occur within the TSS north of Anacapa Island as well as Santa Rosa and Santa Cruz Islands. The pattern of sightings is affected by a lack of survey effort further offshore by the whale watch vessels during this time period. Certain reporting vessels adjust cruises to target the coastal migration of gray whales and do not typically cross the TSS and approach closer to the northern Channel Islands. However, information on humpback whale seasonal feeding patterns and the general distributions of prey species in the study area indicate that humpback whales may indeed be concentrated in inshore waters.

The CINC sightings during June – December include 962 sightings from 1999-2010. The sightings extend from offshore of Santa Barbara toward the north sides of Santa Rosa and Santa Cruz Islands, with less concentrated sightings to the east and west (Figure 7). A southward shift toward the Channel Islands in greatest concentrations is apparent relative to the earlier time period. The distribution of sightings roughly approximates the average transit pattern of one of the whale watch vessels operating out of Santa Barbara Harbor. Greatest concentrations occur north of Santa Rosa and western Santa Cruz Islands, slightly south of the blue and fin whale hotspot evident in the CINC and CRC maps.

The CRC sightings during January – May include 81 sightings. The sightings are sparse because survey effort is typically relatively low in the study area during this time period (Figure 8). The majority of sightings occur north of the Channel Islands and south of the TSS.

The CRC sightings during June – December include 1,734 sightings and are concentrated in a pattern similar to the CRC blue and fin whale sightings (Figure 9). The area of greatest concentration occurs west of San Miguel Island and, to a lesser degree, north of Santa Rosa Island. The 'hot spots' coincide with the 200 m isobath.

Correlations between Cetacean Sightings and the Shelf Break

Blue whale sightings showed an association with the shelf break, as defined by the 200 m isobath buffer (Table 1). Of 1,699 CINC sightings, 1,052 sightings occurred within the isobath buffer, accounting for 62% of all sightings. The CRC sightings indicated a similar correlation between blue whales and the shelf break. Of 4,558 sightings, 3,100 occurred within the isobath buffer, accounting for 68% of all sightings.

Fin whales and humpback whales, though not as closely correlated with the 200 m isobath as blue whales, did also show an association with the shelf break. The CINC sightings indicated

that 58% of the 50 fin whales were sighted within the isobath buffer. The CRC sightings found 29% of the 124 fin whales within the isobath buffer (Table 2).

For humpback whales, both datasets indicated a relatively lower correlation during January – May as compared to June-December. Of 1,000 CINC sightings during January – May, 23% occurred within the isobath buffer. During June – December, 29% of the 962 sightings occurred within the isobath buffer. Of 81 CRC sightings during January – May, 42% occurred within the isobath buffer. During June – December, 58% of 1,734 sightings occurred within the isobath buffer.

Discussion

The analysis presented here is a first order characterization of presence-only cetacean sightings from two projects. Given the lack of survey effort for both projects, only limited inferences can be made on cetacean distributions within the study area that spans the Santa Barbara Channel. Characterization of distributions is limited to those areas where vessels targeted and encountered cetaceans.

Given the caveats, the data do indicate that there are close associations between the three species of large cetaceans examined in this analysis, including blue, fin, and humpback whales, and portions of the shelf break. In addition, hot spots of cetacean sightings indicate that certain areas may have relatively greater probabilities of encountering cetaceans and that more analysis is supported.

Next Steps

There are statistical methods for using presence-only data to determine distribution probabilities. These involve correlating with other surveys, estimating "pseudo-absence" data, and performing spatial correlations with habitat features and then extending those correlations to other areas where there are no actual presence or absence data (e.g. Lutolf et al., 2006; Phillips, 2009; Mateo, 2010). Sanctuary staff are very interested in exploring these techniques and are developing collaborations that in the future may facilitate these analyses. In the material presented here we have taken the first step of correlating whale presence with habitat. At the moment, however, additional staff resources are necessary to perform these analyses in time to complete this assessment for the PARS study.

Literature Cited

Lutolf, M., Kienast, F. and Guisan, A. (2006), The ghost of past species occurrence: improving species distribution models for presence-only data. Journal of Applied Ecology, 43: 802–815. doi: 10.1111/j.1365-2664.2006.01191.x

Mateo, R. G., Croat, T. B., Felicísimo, Á. M. and Muñoz, J. (2010), Profile or group discriminative techniques? Generating reliable species distribution models using pseudo-absences and target-group absences from natural history collections. Diversity and Distributions, 16: 84–94. doi: 10.1111/j.1472-4642.2009.00617.x

Phillips, Steven J., Miroslav Dudík, Jane Elith, Catherine H. Graham, Anthony Lehmann, John Leathwick, and Simon Ferrier. (2009). Sample selection bias and presence-only distribution models: implications for background and pseudo-absence data. Ecological Applications 19:181–197. [doi:10.1890/07-2153.1]

Figures and Tables

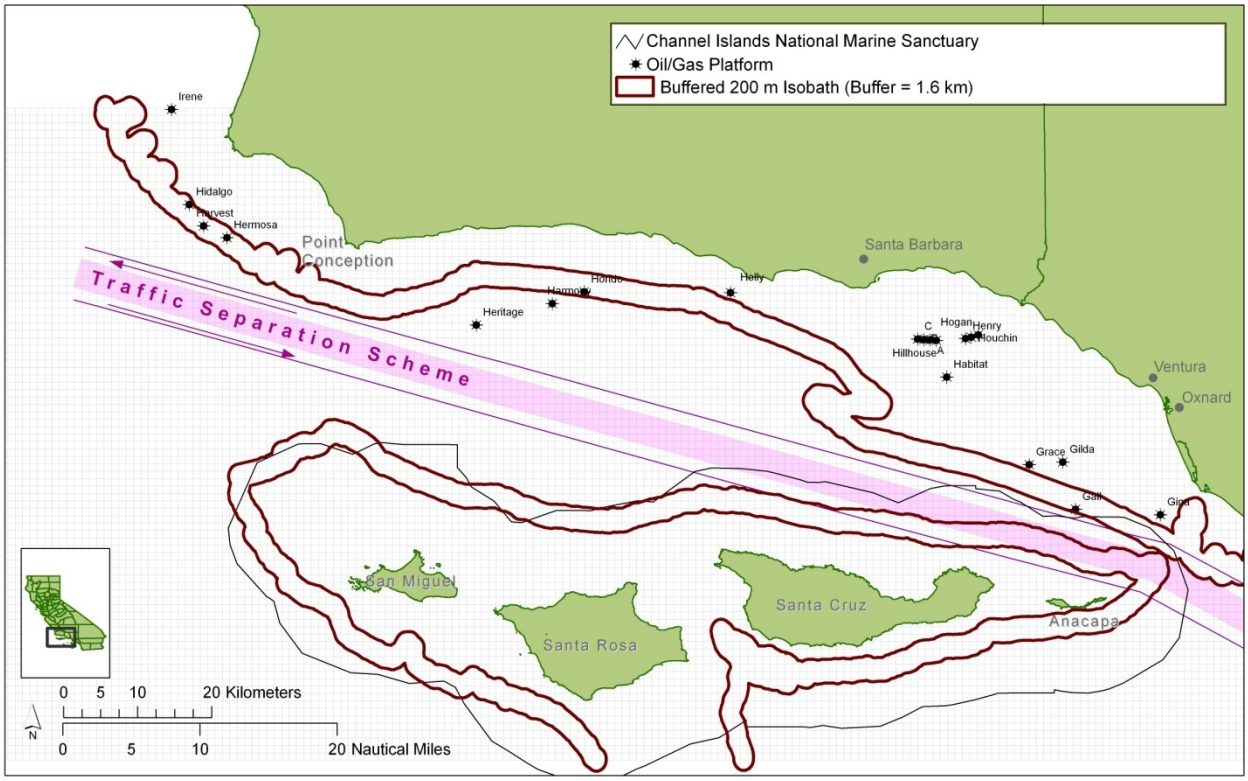

Figure 1. Study Area.

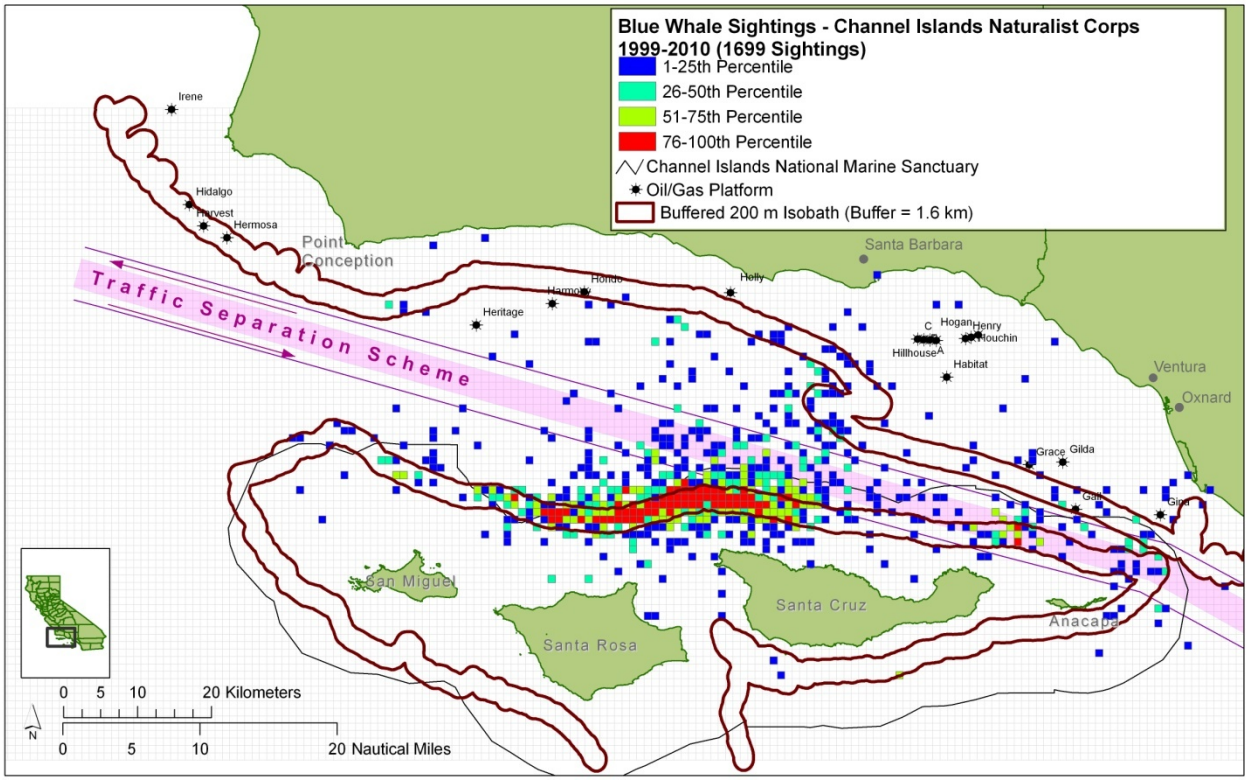

Figure 2. CINC blue whale sightings

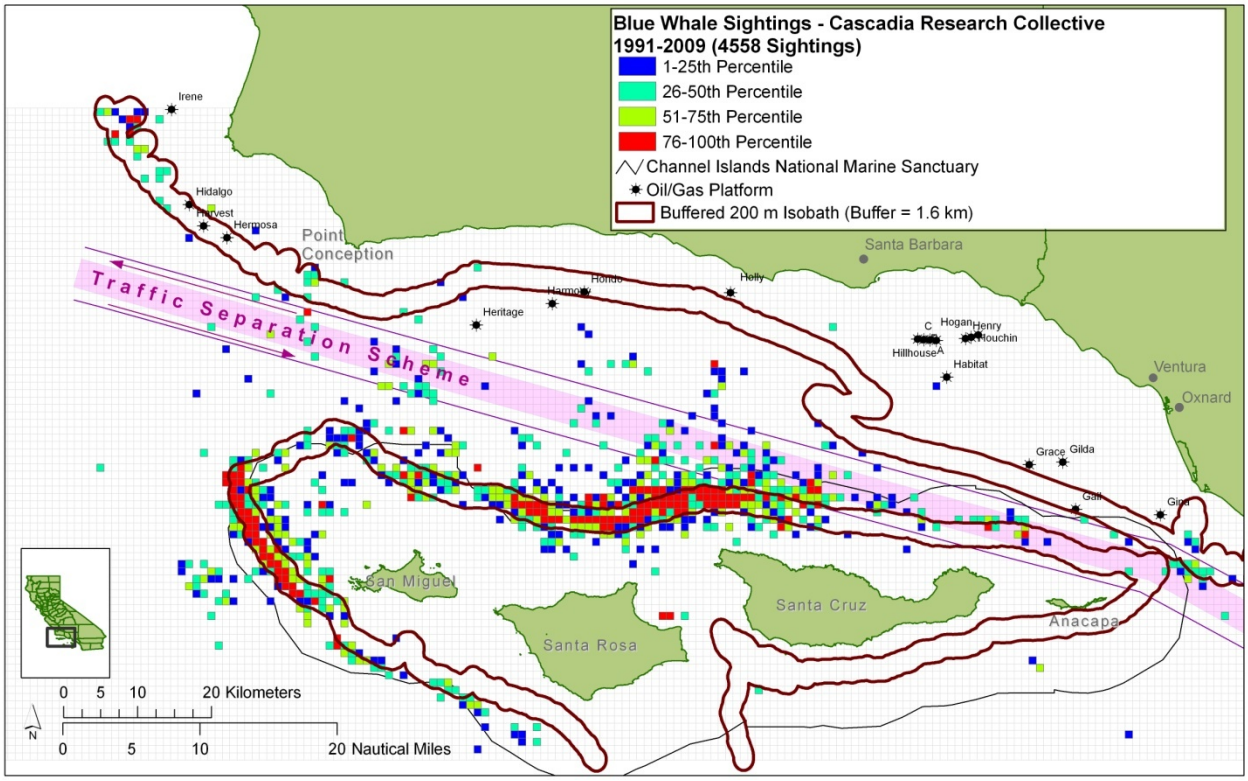

Figure 3. CRC blue whale sightings.

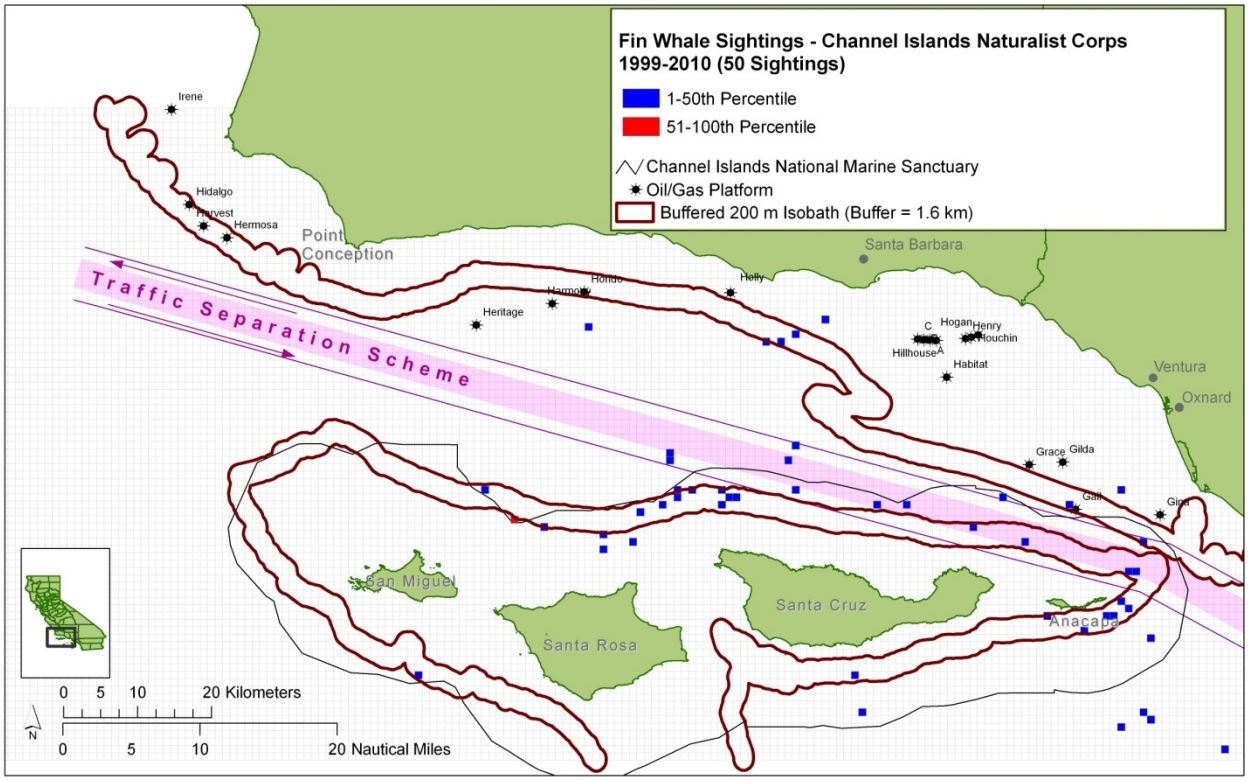

Figure 4. CINC fin whale sightings.

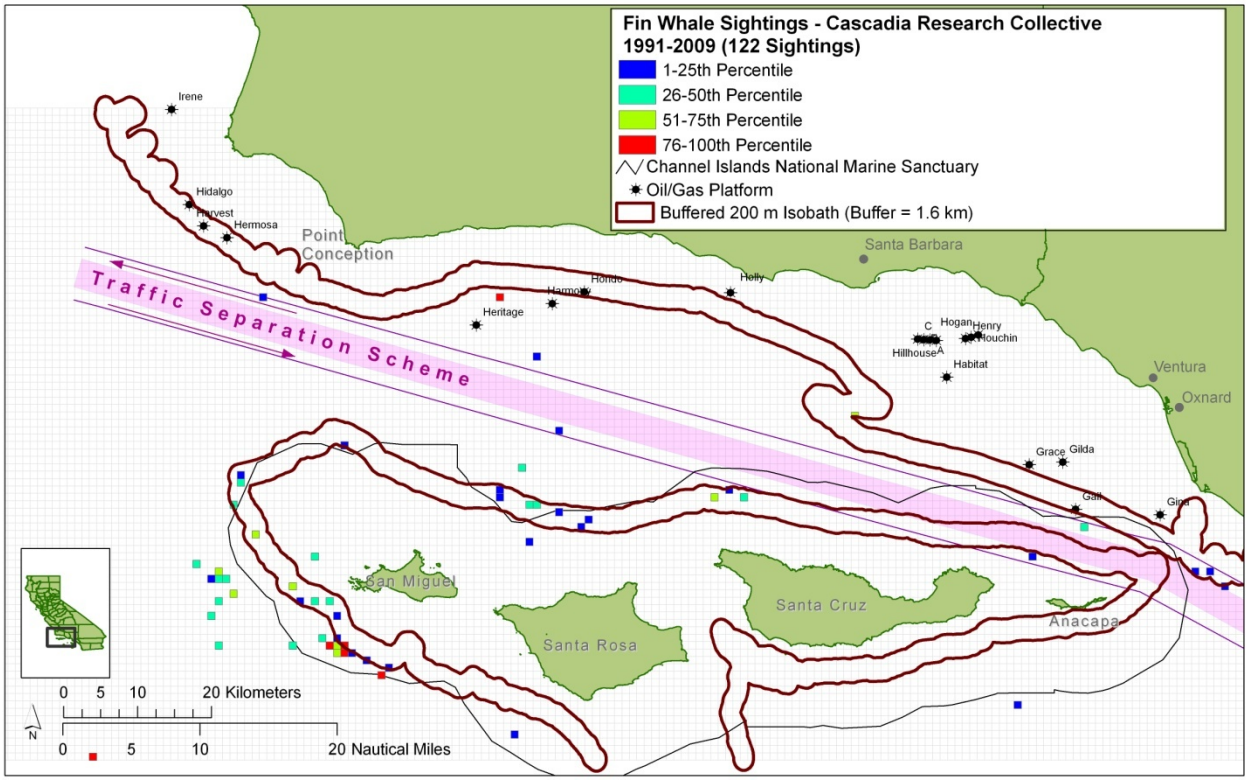

Figure 5. CRC fin whale sightings.

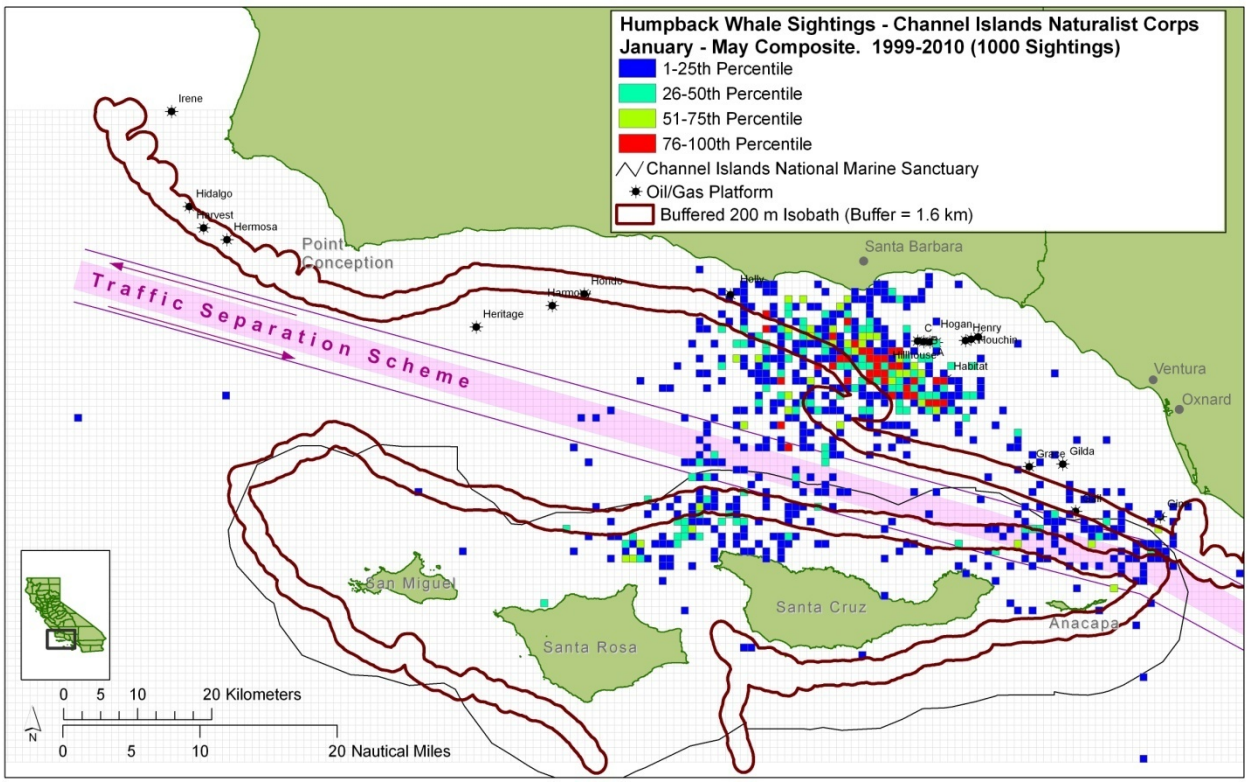

Figure 6. CINC Humpback whale sightings. January – May.

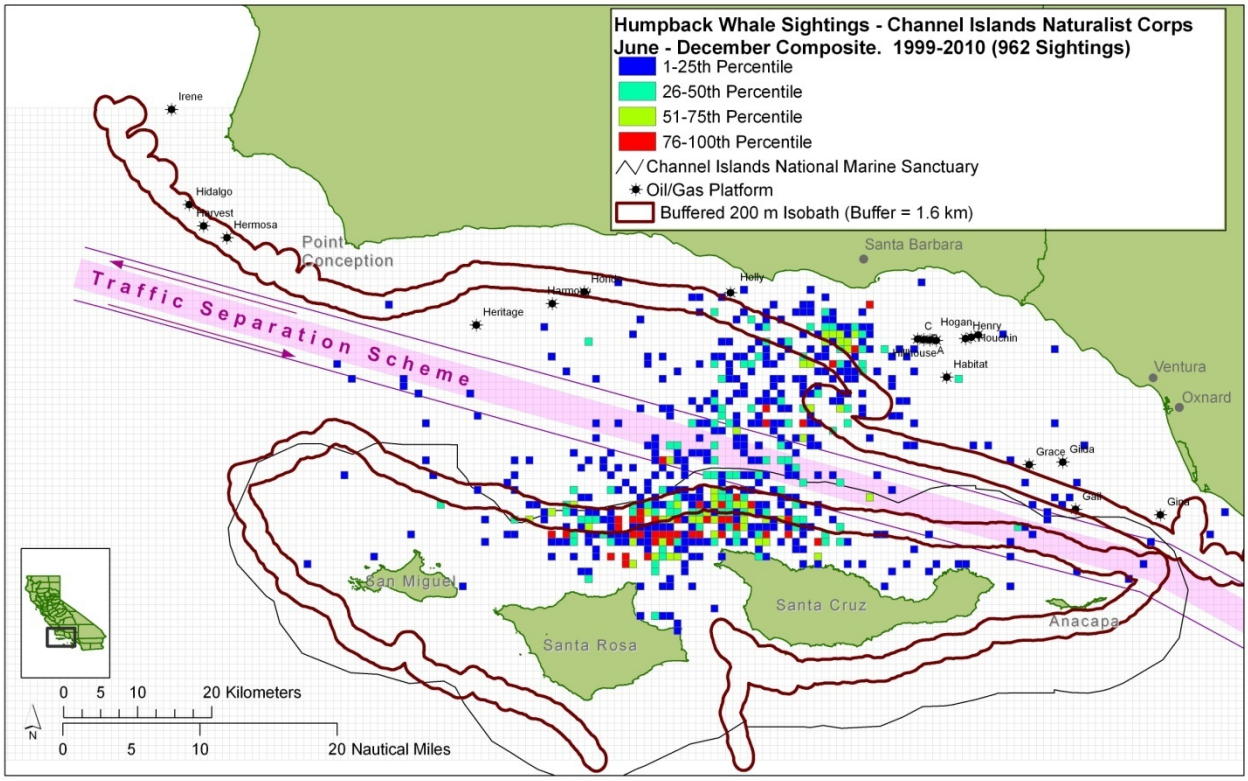

Figure 7. CINC Humpback whale sightings. June – December.

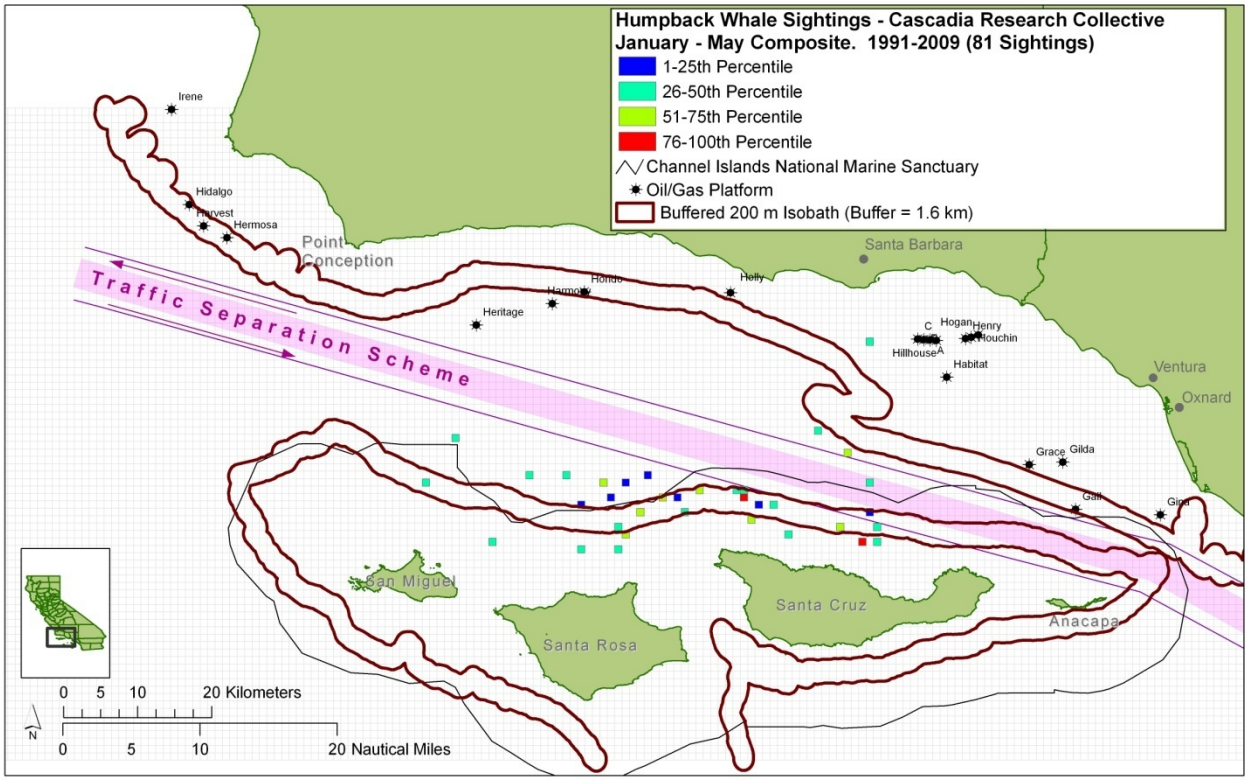

Figure 8. CRC Humpback whale sightings. January-May.

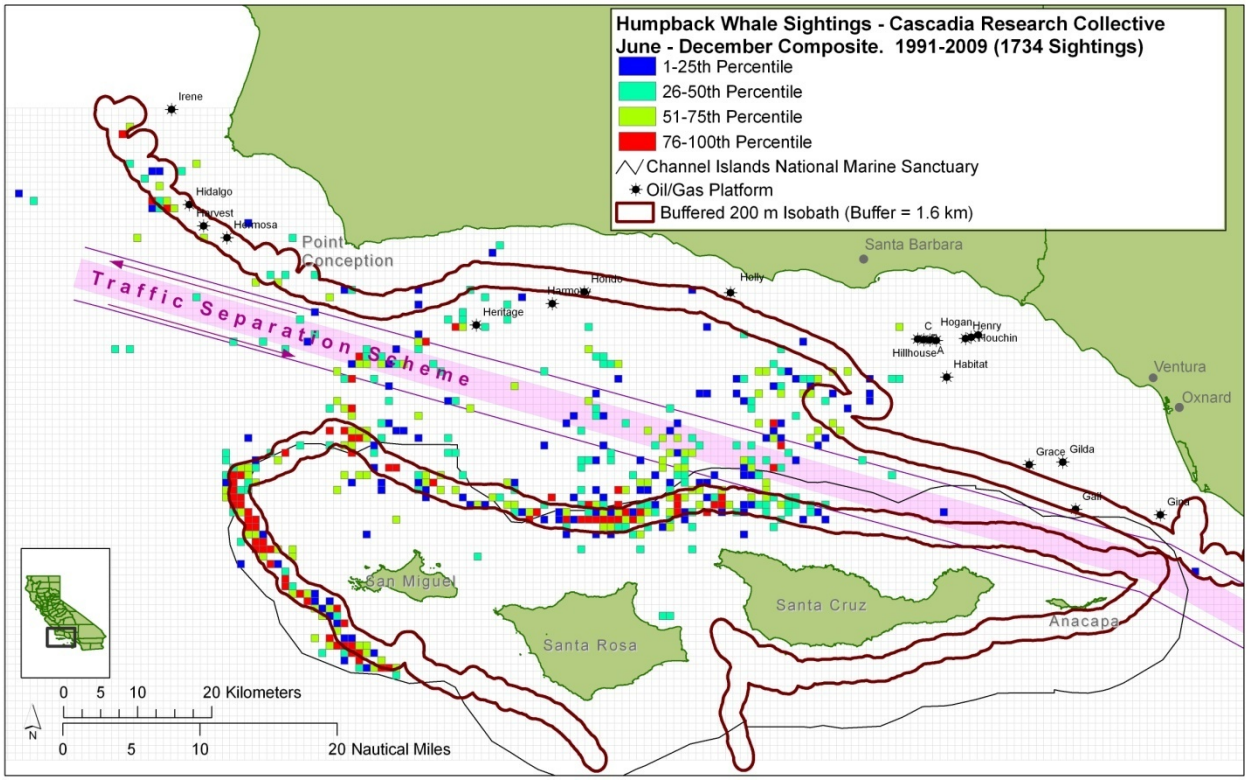

Figure 9. CRC Humpback whale sightings. June-December.

Table 1. Correlation between blue whale sightings and the 200 meter isobath.

	Blue Whales		
Project	**Total # Sightings Within the Study Area**	**# Sightings within 200 m Isobath Buffer (1.6 km)**	**Proportion of Sightings within the 200 m Isobath Buffer**
CINC	1699	1052	62%
CRC	4558	3100	68%

Table 2. Correlation between fin whale sightings and the 200 meter isobath.

	Fin Whales		
Project	**Total # Sightings Within the Study Area**	**# Sightings within 200 m Isobath Buffer (1.6 km)**	**Proportion of Sightings within the 200 m Isobath Buffer**
CINC	50	29	58%
CRC	124	36	29%

Table 3. Correlation between humpback whale sightings and the 200 meter isobaths and delineated by season.

		Humpback Whales		
Project	**Time Period**	**Total # Sightings Within the Study Area**	**# Sightings within 200 m Isobath Buffer (1.6 km)**	**Proportion of Sightings within the 200 m Isobath Buffer**
CINC	January - May	1000	230	23%
CINC	June - December	962	282	29%
CRC	January - May	81	34	42%
CRC	June - December	1734	1012	58%